DOCUMENT RESUME

ED 170 258 SP 014 110

AUTHOR Zacharias, Jerrold R.
TITLE Quality, the Endless Frontier. A Role for the Federal Government in Education.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C. Task Force on Curriculum Development.
PUB DATE Nov 76
NOTE 48p.; Paper prepared for the NIE Curriculum Development Task Force; for related documents, see SP 014 095-115, SP 014 185-186, ED 124 530, ED 140 401, and ED 144 217

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Curriculum Development; Educational Change; Educational Improvement; *Federal Programs; *Financial Needs; *Government Role; Instructional Materials; *Instructional Media; *Publishing Industry
IDENTIFIERS National Science Foundation

ABSTRACT

This paper lists a series of topics that should be considered by the federal government in formulating its role in the provision of quality alternatives to the educational materials now available. The outline focuses on the following: (1) the topics that need attention; (2) pedagogic media and styles; (3) to whom education is directed; (4) basic assumptions about people who might be involved in reform itself; (5) research methodology; (6) the numbers associated with education, including finances, enrollment, and rates of change; (7) aspects of funding, management, administration, distribution, and the institutions that can play the most important roles. Appendixes provide a number of letters written concerning the above topics and the actions of the National Science Foundation. (DS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED170258

QUALITY, THE ENDLESS FRONTIER.

A ROLE FOR THE FEDERAL GOVERNMENT IN EDUCATION

Jerrold R. Zacharias

Education Development Center, Inc.
55 Chapel Street
Newton, Massachusetts 02160
(617) 969-7100

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

A paper prepared for the
NIE Curriculum Development Task Force

November 1976

SP 014 170

Summary

The present paper is an attempt to assist the federal government in formulating its role in the provision of quality alternatives to the educational materials now available. The paper is more a listing of topics that must be considered than a full discussion of the issues. Naturally, a great deal more work should be done to effect such a program. The emphasis here is on topics, mechanisms, and costs. The various processes of learning and teaching are not discussed, even though they merit at least a book-length discussion, and must be addressed in detail before this program can take effect.

If there seems to be undue criticism toward any group involved in the process of education, it is important to remember that the complexity of the system is the major culprit. Even the complexity would be innocent if the system were not so large, with such diffuse tastes, goals, sources of support, and powers.

There is considerable attention to the commercial publishers of tests, textbooks, workbooks, associated books for teachers, and trade books, magazines, etc for the out-of-school markets. It would be easy to say that since the publishers have the authority and responsibility for the intellectual content of education, they should reform and improve their products. But without very

different financial and organizational structures, the publishers cannot afford to provide materials very different from their present products. Any solution to this problem should surely involve the federal government, as well as many other facets of the educational community.

Similar comments apply to the four television networks and the companies which supply their programs -- especially the programs for children and those programs labeled educational. The television industry is, however, so different from the textbook industry that it demands an entirely different approach.

The paper attempts to categorize and list the various other elements needed for provision of improved alternatives to present school programs.

No attempt is made here to discuss those aspects of schools which help students become trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent (the passive virtues). Instead, the present paper focuses on interest, involvement, initiative, and intellect -- and tangible topics to which they apply.

This paper cannot pretend to be a complete overview of all of the problems that need help, with a neat conclusion that tells the government what it should do, when, and how. Clearly there should be an arm of the executive

branch of government that knows what the educational job is, and wants to do it with flair, insight, and courage.

There is no such agency now.

QUALITY, THE ENDLESS FRONTIER.

A ROLE FOR THE FEDERAL

GOVERNMENT IN EDUCATION

Some twenty years ago, a year and a half before Sputnik, I wrote a letter to James R. Killian, Jr., then President of Massachusetts Institute of Technology, proposing a new physics program for secondary schools. It initiated a movement in this country and abroad to provide alternatives to the content of schooling then available. From the start, the movement incorporated these notions:

1. that intellectual content, as well as the vehicles that carry the content, should be of highest quality.

2. that a full and interrelated collection of learning and teaching aids for this content should be prepared, tested, and made easily available.

3. that there are four mutually-dependent working fluids of the education-reform engine which must be understood and attended to: people, ideas, money, and management. All of them are necessary; none is sufficient. The inadequacy of any one can stall the engine.

In a small 1963 book by Paul E. Marsh and Ross A. Gortner, entitled "Federal Aid to Science Education: Two Programs,"[1] they state:

> Any program aimed at massive improvement in school curriculum in this country must come to grips with a mature and integrated going concern. Over the years, the nation's school system has expanded and evolved into a flexible, diverse, and typically pluralistic enterprise. It has governments, professions, and businesses closely coordinated to do a single job -- educate the nation's young. Federal, state, and local jurisdictions have their own roles and responsibilities for schooling and the bureaucracies to meet these obligations. These civil servants have specialized, professionalized, organized, and just about isolated themselves from interference by general government. This freedom is unquestionable and most jealously maintained in curriculum. On the other hand, the production of curriculum materials has grown into a national and private industry of considerable size. While a number of firms are in this business, about a dozen dominate it, and these few have recently enhanced their leadership through mergers. Schooling is a closely knit undertaking.
>
> A first order of business for any program that wants to improve schooling on a really large scale is to begin to understand how this whole system fits together and works.

This is not surprising. They are referring to the roughly half-dozen major publishers who supply the intellectual fluid in the form of texts, tests, and everything else that the schools buy.

The electronics industry is similarly dominated by a handful of companies, the aircraft industry by like numbers, and the automobile industry by even fewer. Like many others, the first two of these large industries spend roughly ten percent of gross sales on research, reform, and development; and almost all of this money comes from sales to the federal government. No one questions the proprieties, the procedures, or the product. But the automobile industry, the education industry, and the railroads spend very little on improvement.

In 1956, we were beginning to learn how the federal government, mostly three agencies (National Science Foundation, Office of Education, and Agency for International Development), might find ways to parallel the successful procedures in other industries for the benefit of education.

This paper rests on the fact that the publishing industry for school supplies cannot afford financially to renew itself. The economics of this business phenomenon might best be left to others. But the underlying cause is surely in two troubles: competition for price with too little regard for excellence, and inadequate mechanisms to find relative excellence when it exists. In twenty years of dealing with publishers, especially the successful ones, I have found that their first attitude is often, "Don't change everything very much -- we need to make money."

A look at the criteria imposed by a publisher in preparing a manuscript, or collection of manuscripts, shows that the first question is, "How many will it sell?"

The following chapters are devoted to the questions, what, why, how, who, for whom, when, where, how much, and who pays? The questions of whether and whither will find their way throughout.

Chapter One: What Topics Need Attention?

The phrase "academic disciplines" might convey the meaning of topic better than the bare word, but suffers from the restrictions of the academic disciplines. Much of the honest intellectual content we require may need unfamiliar packaging.

First: Language, Literacy, and Literature.

In the back-to-basics movement, there is much discussion of the problem, "Can the children learn how to read?" If the attention were focused on "Do the children read, and what do they read?" the problem would look far different. It would demand that the publishers pay attention to the tremendous diversity of peoples' interest. How children become interested in one thing or another, I do not know. I am a physicist, the son of a lawyer and a musician. Why my interests occur as they do is a mystery to me. But

we should be able to provide interesting materials in every one of hundreds of interests. Only a few of these will be best sellers. It is up to the federal government to find mechanisms to take the financial burden and risk of this diversity off the backs of the publishers.

Second: The Natural Sciences, the Applied Sciences, the Technologies Separately and in Combination.

Beginning in 1956, the National Science Foundation has had quite an impact on the business of finding out how to handle these problems. The natural sciences taken as disciplines separate from one another made remarkable progress. The United States overcame the two-year lead in such subjects held by the best students in Western Europe, Britain, and the USSR. But like them, we have not yet found ways to bring along the majority of students in similar ways. Nor have we put in enough effort or money to try tying mathematics and the sciences to their close relatives in the practical worlds of health, medicine, the technologies, etc.

The NSF effort not only leveled off too early, but has dwindled since. The NSF has the most coherent intellectual constituency in the world, a community of perhaps a million scientists. But the NSF needs to stand up and say, "Look what we did, and look what we

still need to do. Here's what it will cost, and here's who will do it, and remember that he who has made no mistakes probably has never done anything else either." It was Enrico Fermi who castigated the Atomic Energy Commission for not making enough bombs that failed to explode, and for not making enough nuclear reactors that did explode. One must learn to walk near the edge of a precipice with faith in himself.

An incidental comment: The professional scientists and technologists of this country seem to believe that, except for themselves, scientists and technologists are made after the age of twenty. Each one knows that he began to bloom in science and technology at the age of four, or nine, or twelve. In no other way can I account for the difficulties of the pre-college programs of the NSF.

Third: People, People's Problems, and How They Got That Way.

"They" here refers to both <u>people</u> and <u>people's problems</u>. I have tried to avoid jargon by describing psychology, sociology, and history this way, and for a simple reason. People should start learning about people and people's problems long before they can handle any jargon. We need a tough study to formulate this problem better.

Fourth: Peop[illegible], People's Problems and the Law -- Or the Rights of the Individual Versus the Rights of Others and the Rights of the Group.

This is not a question of how many laws one can learn, but needs to start by confronting some of the human problems. Study of this sort ought not to begin with the Constitution and Bill of Rights, but rather with the needs which arise from the inevitable conflicts between individuals and groups.

Fifth: All of the Arts and Their Relationships to Everything Else in this Chapter.

There is a natural urge for an artist, or a scientist, or a writer, or a bricklayer, or any other professional to think that his profession can be separated from the rest of mankind. This can be said another way: Legend has it that the Lord tired of the Tower of Babel. But somehow the idea of punishing mankind for its sins remained. Men later invented the Academic Tower of Babel, not only with inseparable walls between the so-called disciplines, but with heirarchies in which theory takes precedence over experiment.

Sixth: Optimism is More Time-Consuming Than Pessimism.

Assuming success in the individual disciplines of the Tower of Babel, we should look forward to what I call

the moving goals of education and the moving goals of intellectuality. Without some way for people to understand the inter-disciplinary aspects of topics such as ecology, the impending Malthusian catastrophy, the economies, the environment, arms control, peace, power, energy, and the Four Horsemen of the Apocalypse, it is likely they will continue to vote for presidents and dictators who have shaky fingers on the atomic trigger. Education cannot do everything, but the leadership of every country should understand the irreversibility of mixing science and technology with the seven deadly sins.

* * * * * * *

This looks like a tall order. It is. But I know from experience that it is possible to enlist the attention of remarkable people to just such problems. Think small, ask them to help you teach sixth grade long division, and you get what you deserve. But put them in search of the worthwhile, and they just might find a way.

Chapter Two: Pedagogic Media and Pedagogic Style

The intellectual content discussed in Chapter One needs encoding in a variety of forms. The computer industry has two words useful here: hardware and software. Industry is trying to handle improvements in educational hardware. But even hardware still needs more help for school purposes. However, the major theme of this chapter is the software aspect.

First: Books, Tests, Magazines, Games, Laboratories, Films, Television, Calculators, Computers, Office Copiers, etc.

If one multiplies the diversity of media by the diversity of interests, by the diversity of age groups, by the costs of learning how to make the materials and test them, the pot of money looks vast. If money were no obstacle, the major obstacle would be people.

Tests: All but one of the learning aids listed above simply provide additional help and diversity in the learning process. To be sure, the additions are not simply linear in the sense that 2 + 3 = 5. (Item 2) plus (Item 3) may provide much more learning than the simple sum of the two used in isolation from each other. Tests are different. They control the content, frequently the style, and surely the image of what education is supposed to be. In 1975, the country spent $120 billion/year on education, of which $200 million/year was spent on tests. The tests call the

tune on the texts, which determine what the students think they are supposed to learn, and the teachers believe that they are supposed to teach. The text industry lies somewhere above $1.5 billion/year, but it is the $200 million/year tail that is wagging the $120 billion/year dog. (I have a seventy pound poodle with a two ounce tail.) Do we need the federal exchequer to come to the rescue? The answer is "Yes -- but only 'if'": Only if there are people prepared to take on large independent projects aimed at helping the publishers radically improve the tests they publish. I have studied many of the presently available tests, and have come to the conclusion that the test publishers do not take to heart the large volume of criticism they absorb. But they cannot afford to, either financially or emotionally, which implies that some radically new alternative mechanism must be designed and funded.

Television too requires special attention here and for several reasons.

1. Television viewing is almost irresistable, and has reached almost saturation dimensions in this country; that is, until the channel capacity goes up by factors of ten or a hundred, as someday it will. But the programs will still have to compete with each other for the viewer's attention.

Present studies show that 28 hours/week is the time spent watching television, on the average, by minority children in America

2. Television is a young and immature art form, requiring nurture and tough-minded attention to taste.

3. Use of television in the processes of education has not been sufficiently explored. Some indications of the problems which arise are given sensitive treatment in a latter from Mitchell Lazarus, Senior Staff Associate at Education Development Center, attached as Appendix 3.

4. Although the costs of preparing educational television shows seem high (typically around 100 thousand dollars per finished viewing hour), the costs per viewing hour per person are small. Think of a show with a small audience, say 100,000 people; the cost of production is then one dollar/person/hour. But if the audience is one million, it is ten cents/ person/hour. In the United States, only the federal tax base can handle such a peculiar distribution of costs. In Japan, on the other hand, the postman collects a monthly fee which goes to NHK, the central television agency, for its support.

5. It is fair to say that the country does not yet have enough real talent in the networks and the stations to produce high-class television. At least this is one way to account for the quality of available programs. Like every other problem in this report, the bottleneck sequence is management, dollars, people, and ideas. Or perhaps it is all due to the Nielson ratings and public taste.

Second: What Vehicles are Necessary for People, Including Students, Parents, and Teachers, to Become Interested in the Discussion?

How do we stimulate the use of the various media listed above by using any one of the others? Simply: Can television sell books, magazines, and newspapers? Can newspapers sell television?

Third: The Importance of the Student's Larynx

It should surprise no one that people more readily remember what they themselves say than what they hear or read. There is much heed paid to learning by doing, through the so-called "discovery method." We must find ways to assist children's talking to each other about the topics we expect them to learn. This is a tall order, but I am sure it can be done. If we provide the students with all of the answers, they will have nothing to talk about.

Nor should we supply them with <u>all</u> of the questions -- just enough to incite more.

Fourth: Existence, Correctness, Up-To-Lateness, and Integration.

Fifth: Schooling Styles, Book Styles, Education Styles, and so forth.

Sixth: Schools and Other Social Institutions Which Bear on Education -- Museums, Libraries, Storefronts, Restaurants, "Medias."

* * * * * * *

The items above are sufficiently self-explanatory that they do not need detailed explanation here. In a report of a "Task Force on Education" (appointed by President Lyndon Johnson with John Gardner as Chairman), enough has been written already. This report should be reproduced and distributed widely.

Chapter Three: To Whom Is All This Directed?

Clearly education is for everyone. Properly viewed it is an endless enterprise. Fundamental to mankind is the boredom which comes from experiencing nothing new. To use a term from the differential calculus, the rate of change is at least as important as the thing itself.

Even industries and the people who run them are not content with just making money; they want to grow. The human mind, more than its associated skill systems, seems not to saturate and requires no more space, no more food, when packing information in fast than when it is slothful and slovenly. Aphorisms like "Know thyself" are not the right ones; "Let your intellect grow," is. If this sounds too philosophical, try walking through a nursing home among the vegetables, and compare them with the intellectually active octogenarians you know about.

What people are willing to do can determine what ultimately they can do. It is up to us to see that the public can walk up intellectual slopes gentle enough that they are not frustrated by unnecessary barriers.

Chapter Four: Basic Assumptions About People Who Might Be Involved in Reform Itself.

This chapter, which I don't yet know how to write, could almost be written by a computer -- except that the subject is not really understood and appreciated by the education community either. The questions might be:

1. Are humans more various than insects?
2. How many different environments must we provide?
3. Who has the requisite breadth of view to foster public growth?

4. How do we make "education" a respectable profession?

Chapter Five: The Recursive Nature of Everything. The Competition Between Short Term and Long Term.

One of the major needs of successive approximation is that the successive approximations converge. Another way to say it is, "Do you know when to quit?" If you keep drilling dry holes, is something fundamentally wrong with what you are trying to do? Perhaps it is true that the Mozarts of this world can compose out of their back pockets just in time for the opera to be performed, but most people cannot do that. They will make mistakes, and the feedback mechanisms they need must be paid for.

Chapter Six: Engineering-Style Research Versus Scientific-Style Research.

What we need in education is not "research" as most people understand the word. A scientist doing research tries to find out as much as he or she can about a particular phenomenon, and is willing to look at smaller and smaller facets as necessary. An engineer, on the other hand, cannot ignore any issue at all that bears on successful operation of the product, and must obtain at least a

working knowledge of all the causes and effects that make the device work well -- or badly.

Only in trying to engineer with full attention to every difficulty and every pitfall does one find the full list of engineering-style research problems. This topic alone merits full discussion including what, why, how, who, for whom, when, where, how much, and who pays? The effort must be recursive, and the scale of the operation is extensive and expensive. For example, it is impossible to find out what's wrong with educational television without making many programs. One is not enough.

Chapter Seven: The Numerologies

First: Bucks, Kilogucks, Megabucks, and Billions of Dollars.

Second: Percentages and Various Time Rates of Change.

Third: Numbers of Students, Teachers, Administrators, and so forth.

Fourth: How Much Will the Whole Thing Cost?

The numbers problem is staggering. It would even be staggering in a country as coherent and as small as Israel, whose population is 1/75 of ours. Certainly, if Israel can afford to do what they are doing about education

reform, then we should be able to do one hundred times as much. Do we need to invent an enemy as an incentive, as indeed Israel has in fact?

We must first set the scale -- the sizes and rates of activity to make a major alternative to some piece of schooling that could work much better than is now the case. As an example, I am always tempted to use the first such program that I tackled -- i.e., physics for secondary schools -- because I know so well what occurred. But here I would prefer to discuss an alternative to existing mathematics in the elementary school. There are many reasons, not the least of which is that my head is full of it right now, but also that in 1976 we are much more sophisticated about all of the systems engineering aspects of the operation. A full revision of school mathematics for grades K through 12 is important, difficult, and urgent. Important, because mathophobia is rampant, whereas a reasonable facility with mathematical ideas is a real requirement, not an artificial "prerequisite" for entry into one profession or another; difficult, because the professional people who "own" the subject are unable to empathize with those who have trouble; and urgent, because the public reaction to the utter failure of the "new math" is a return to computation under the rubric "back to basics." All of this when anyone can buy a calculating machine with six figure accuracy for less than the price of a textbook.

Sometime in 1973, a group at Education Development Center of Newton started the development of a collection of learning aids for children in grades 3, 4, 5, and 6. We believed that we would need to produce some 300 half-hour television shows with printed guides; that we would have to make diagnostic, non-frightening, and non-secret tests for children; that we must prepare new books for children, for school teachers, and for parents; hands-on activities, etc. We wanted to try to establish new relations with publishers, teachers, and parents in newly-organized ways. So far, we have spent $5 million, produced 52 television shows, and made about one-third of the necessary tests. By steady attention to subject matter, we have gotten our heads clear about roughly half of the mathematics, but have made only a little headway with language as it affects the understanding of mathematics. A rough guess at the need is another $10 million and three more years, which adds up to $15 million over a five year span. This is a reasonable and conservative estimate.

Incidentally, television costs can be approximated at $50,000 per one-half hour, or for an additional 200 shows: 200 x 50,000 = $10 million. Is this a lot or a little? Size is always relative. A clear basis for comparison is the amount that the schools spend now over a ten year span, for we should amortize our development figures over a ten year period.

In the seven grades from kindergarten through six, there are 28 million children, for whom the schools spend roughly $1,000 per child per year, or $28 billion per year, or $280 billion over ten years. Of this sum, a quarter or a fifth, about $70 billion, goes into teaching math. Compare $15 million with $70 billion and we get two hundredths of one percent, or $2 our of every $10,000.

There is an intermediate figure worth looking at: How much do the schools pay for books and materials for math over ten years? At $2/child/year over ten years we get:

28 million children x $2/child/year x 10 years,
or $560 million, or $56 million/year.

Almost all of this filters through the text publishers. Reading materials cost two or three times this, or about $1.5 billion over ten years.

Let me dispose of two viewpoints, both of which I believe would be profitless.

First, we could try to make a grand total annual figure for preparation of new materials. But the total sums come out so high, if we look at everything, that the number would be, for the unwary, discouragingly out of reach. (So would the man-on-the-moon program.) Appendix I shows the fiscal scales of American school programs -- that they have increased rapidly over the years, even when corrected for Consumer Price Index, also included in Appendix I.

Correcting the figures for the post World War II baby boom does not change the trend.

My conclusion is that the country wants good education, and is willing to pay for it.

Second, since the textbook industry is $2 billion per year, why not take the cost of improvement out of that? This figure is gross sales, not profit, which at best is some ten percent, which is the incentive for risk capital. So the problem remains with the only group that can handle it -- the federal government with its national tax base.

Evidence that these problems are not new appears, as Appendix II, in a letter to the National Science Foundation, dated November 10, 1964, just twelve years ago.

Chapter Eight: Chronology

First: When does one start? With what does one start? How does one start?

Second: How long does it take?

Third: How to set up and exploit exponential growth?

Chapter Nine: Who? What Institutions With What Expertise Can Do Some of the Jobs?

First: By whom can the needs be met?

Second: How does one avoid the beartraps provided by the inattentive, the ineffective?

Third: Should we turn to the people who for decades have not done it properly?

Chapter Ten: Funding Sources, Management and Administration

First: The importance of critical mass.

Second: The uses and abuses of dispersion of effort and money.

Third: Politics and the question of constitutionality.

Fourth: Legislation.

Chapter Eleven: Problems of Distribution

First: Who can not pay?

Second: Who does not pay, but should?

Third: The unequal distribution of $120 billion per year.

Fourth: Publishers, royalties, and traditions.

Fifth: The education and learning business versus the dollar business. Which controls which?

Chapter Twelve: Conclusions and Guidelines

Perhaps this should come first. I make a number of basic assumptions concerning the basis of a national education reform program.

There are fundamentally two ways to spend money on education. One is called additive or extensive, and the other is called multiplicative or intensive. A National Science Foundation report called "Important Meetings Announcement and Draft Guides," September 1976, states:[2]

> While considerable flexibility and latitude in format is possible, projects must represent a significant departure from usual practice and provide a potentially transferable practical alternative to it. Implementation or adaptation of already-developed models does not fall within this program. Significance may be argued by describing the important national needs and opportunities to be fulfilled, and the likely use of specific clienteles. The criterion may, for example, be met by either widespread use or the satisfaction of an important specialized need.
>
> Proposals must convincingly demonstrate likely national effectiveness, generalizability and transferability. Local improvements or projects whose

> results are site-specific will be excluded regardless of their intrinsic quality or the local need they fulfill. In order to assist in realizing this national impact potential each development project must have, either as an integral part or as a separate effort, an appropriate capability for documentation and/or evaluation of final versions of project outcomes which will generate objective, reliable, and valid knowledge and information about the outcomes.

What they are saying is that the cities, states, counties, however the school districts are based, should pay their own way for their own local needs. Funds that can be distributed by formula only add small fractional help to the cities and states. The Office of Education distributes almost $6 billion a year this way. One can think of it in terms of his own income: In 1976, any single-digit-percentage raise just barely keeps up with the inflation. It does not provide a way to change anything.

An intensive or multiplicative expenditure can change effectiveness by changing the quality of a substantial fraction of programs already out there and being paid for. The original NSF curriculum reform projects did just this with great success. I hope they still want to do it this way.

A detailed account can be found in the document by Marsh and Gortner referred to at the beginning of this paper. They understand and document that the National Defense Education Act was only additive or extensive,

whereas PSSC, the first of the well-engineered and big reforms, changed large fractions of the teaching of physics. Other fall-out from the program was even larger. Their final paragraph reads:

> A close look at what each program has done and how each has worked cannot deny either one a place in the nation's educational system. Nevertheless, the weight of experience indicates that a priority can now be suggested. Historically, there was logic in the Congressional view that the PSSC and undertakings like it represented the first order of educational business. Title III science could then be a useful, but ancillary, complement. On scientific, educational, political and economic grounds, this order of preferece makes even more sense now.

FOOTNOTES

1. Marsh, Paul E. and Gortner, Ross A., *Federal Aid to Science Education: Two Programs*, The Economics and Politics of Public Education 6, Syracuse University Press, New York, 1963, p. 1.

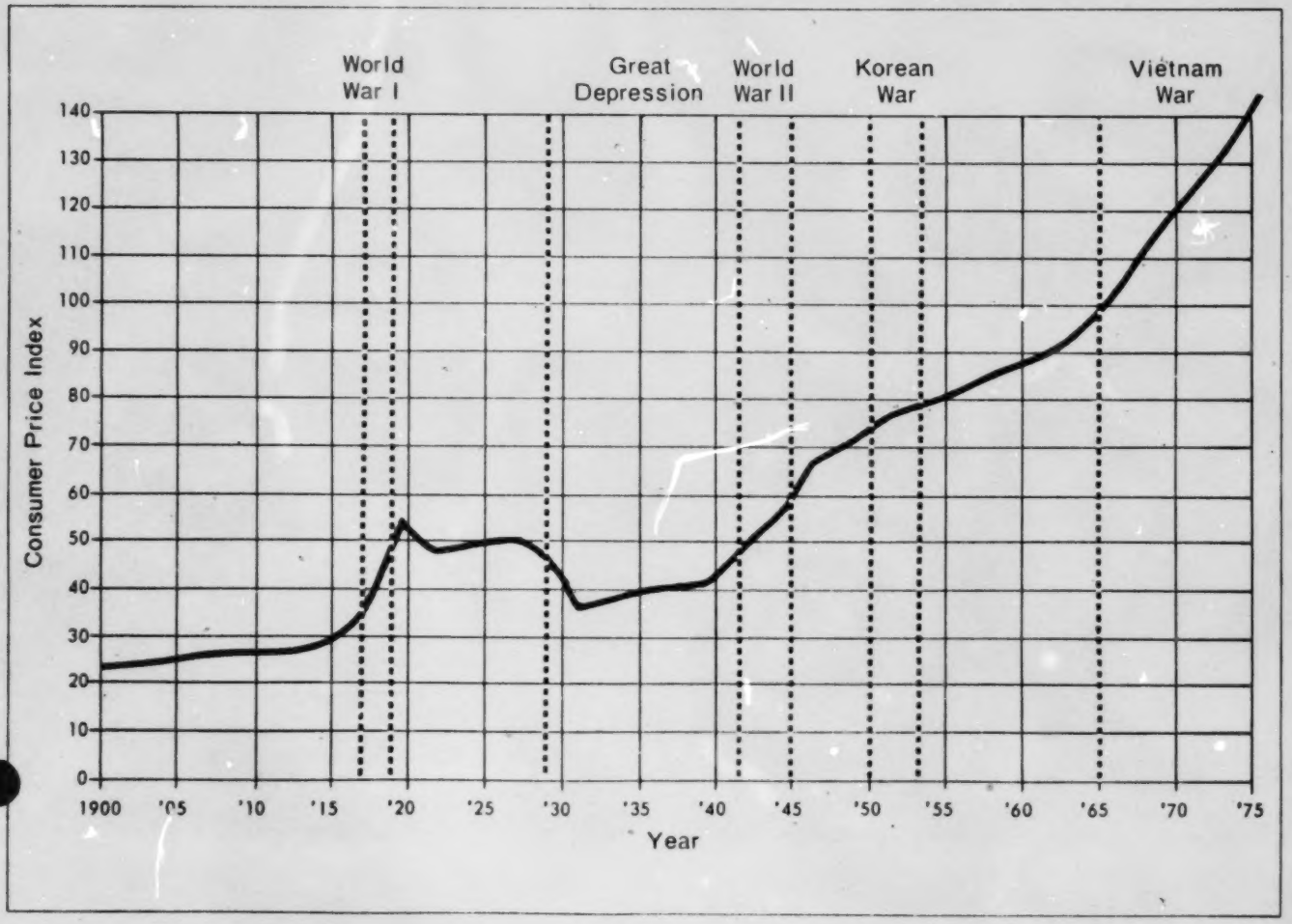
2. *Important Meetings Announcement and Draft Guidelines*, National Science Foundation, September 1976, Science Education Directorate, Division of Science Education Development and Research, p. 1.

APPENDIX I

Reprinted by permission of the Dushkin Publishing Group, Inc., Guilford, CT 06437

Focus

Macroeconomics



APPENDIX I

Reprinted from The Condition of Education, 1976 Edition
National Center for Education Statistics

Table 1.21.--Estimated expenditures of educational institutions, by source of funds: 1959-60 to 1975-76[1]

Source of funds by level and control	1959-60	1961-62	1963-64	1965-66	1967-68	1969-70	1971-72	1973-74	1975-76
	AMOUNT, in billions of current dollars								
All levels:									
Total, public and nonpublic	$24.7	$29.9	$35.9	$45.2	$57.2	$70.2	$83.0	$98.3	$120.0
Federal	1.7	2.5	3.3	5.0	6.8	7.4	9.4	10.1	11.8
State	7.2	8.7	10.6	13.1	16.8	22.7	26.3	32.8	40.9
Local	9.7	11.2	12.7	15.1	18.6	22.2	26.4	31.2	37.2
All other	6.1	7.5	9.3	12.0	15.0	17.9	20.9	24.2	30.1
Total, public	19.7	23.4	28.0	35.3	45.5	56.8	67.4	80.3	98.0
Federal	1.2	1.7	2.2	3.6	5.1	5.7	7.5	8.0	9.4
State	7.2	8.6	10.5	13.0	16.7	22.6	26.1	32.5	40.5
Local	9.7	11.2	12.7	15.1	18.6	22.1	26.3	31.1	37.1
All other	1.6	1.9	2.6	3.6	5.1	6.4	7.5	8.7	11.0
Total, nonpublic	5.0	6.3	7.9	9.9	11.7	13.4	15.6	18.0	22.0
Federal	.5	.8	1.1	1.4	1.7	1.7	1.9	2.1	2.4
State	(2)	.1	.1	.1	.1	.1	.2	.3	.4
Local	(2)	(2)	(2)	(2)	(2)	.1	.1	.1	.1
All other	4.5	5.6	6.7	8.4	9.9	11.5	13.4	15.5	19.1
Elementary and secondary schools:									
Total, public and nonpublic	18.0	21.4	24.6	30.0	37.3	45.5	53.8	63.3	75.1
Federal	.7	.9	1.1	2.1	3.0	3.3	4.6	4.6	5.3
State	5.6	6.7	8.0	9.6	12.1	16.3	18.4	22.7	27.4
Local	9.5	11.0	12.4	14.7	18.0	21.3	25.2	29.7	35.1
All other	2.2	2.8	3.1	3.6	4.2	4.6	5.6	6.3	7.3
Total, public[3]	15.9	18.7	21.6	26.5	33.2	41.0	48.3	57.1	67.9
Federal	.7	.9	1.1	2.1	3.0	3.3	4.6	4.6	5.3
State	5.6	6.7	8.0	9.6	12.1	16.3	18.4	22.7	27.4
Local	9.5	11.0	12.4	14.7	18.0	21.3	25.2	29.7	35.1
All other	.2	.1	.1	.1	.1	.1	.1	.1	.1
Total, nonpublic	2.1	2.7	3.0	3.5	4.1	4.5	5.5	6.2	7.2
Federal	---	---	---	---	---	---	---	---	---
State	---	---	---	---	---	---	---	---	---
Local	---	---	---	---	---	---	---	---	---
All other	2.1	2.7	3.0	3.5	4.1	4.5	5.5	6.2	7.2
Institutions of higher education: education:									
Total, public and nonpublic	6.7	8.5	11.3	15.2	19.9	24.7	29.2	35.0	44.9
Federal	1.0	1.6	2.2	2.9	3.8	4.1	4.8	5.5	6.5
State	1.6	2.0	2.6	3.5	4.7	6.4	7.9	10.1	13.5
Local	.2	.2	.3	.4	.6	.9	1.2	1.5	2.1
All other	3.9	4.7	6.2	8.4	10.8	13.3	15.3	17.9	22.8
Total, public[3]	3.8	4.7	6.4	8.8	12.3	15.8	19.1	23.2	30.1
Federal	.5	.8	1.1	1.5	2.1	2.4	2.9	3.4	4.1
State	1.6	1.9	2.5	3.4	4.6	6.3	7.7	9.8	13.1
Local	.2	.2	.3	.4	.6	.8	1.1	1.4	2.0
All other	1.5	1.8	2.5	3.5	5.0	6.3	7.4	8.6	10.5

See footnotes at end of table.

APPENDIX II

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF PHYSICS
CAMBRIDGE 39, MASSACHUSETTS

November 10, 1964

Dear Lee:

In response to your suggestion, I have put down some thoughts on increasing the support by the National Science Foundation of Course Content Improvement and related educational research and development in FY 1966.

The NSF budget for FY 1966 appears based on the premise that we have just about reached a ceiling in the projects that can profitably be supported in Course Content Improvement. I do not believe that this premise is correct. I believe that we should support a program of vigorous expansion. Moreover, the justification for such support ultimately can come only from some notion of what education could be like and the role it could play in building the Great Society. Just as one can imagine vast advances in science and in technology, so one can imagine vast improvement in education.

Once one really gets launched in thinking about what is possible in education, the size of the task becomes frightening. But this does not mean that there are not things to do first and things to do second, and that there is not a limit to what one can spend. The limit, however, should be set, not by funds, but by the number of persons that one can recruit and educate to this effort.

1. A New Goal for Education

There is an approach to education that treats it primarily as a kind of substance, as so much intellectual content, which is first in the teacher's head and then transmitted to the student's head. This is the approach, I submit, that characterizes much of education as it is actually practiced in our schools; it also characterizes a proportion of the first wave of curriculum improvement. Now, one does not have to be content with this kind of education. Instead of simply reading about or being told about some subject matter, one can develop an approach that enables children to learn things for themselves through being involved directly, being able to shape, change, manipulate, the subject matter they are studying--from playing with blocks to playing with microscopes.

The first kind of education prepares you to be a quiz kid (although you may learn to be other things outside the schools and may not succeed in being a quiz kid) and the second kind seeks to foster inventiveness and initiative. Let me call this second approach the method of involvement.

This is not to say that educators and philosophers and parents have not talked about the method of involvement (or learning by doing) before. What I am claiming is that this has been mostly talk, mostly exhortation. What is lacking are ways to translate this idea into practice--the instructional materials, the curricula, and the programs of teacher education that really can make such learning possible in the school.

As evidence that our present educational system is not given over to the method of involvement, but is devoted instead to the conveying of information, I would ask only that you look at our ubiquitous tests. They test information and rest on essentially bookish operations. It is as difficult to test inventiveness as it is to foster it. Moreover, our testing systems operate to increase the uniformity of our schools when, what we should be seeking, are ways to promote its diversity.

Developing educational programs based on the method of involvement is hard. That is why it has not been done and why it is our primary task. But this does not mean that we should not at the same time learn how to do other things in the schools. We must explore the role of drill, of gaining such things as facility in handling mathematical operations; the role of various teaching devices such as teaching machines, films, and TV; and the role of testing where, perhaps, we should learn how to find out what the student knows instead of what he does not know.

2. A Huge Undertaking

Educational R&D is not only a tough job, it is also a sizable undertaking, calling for more than just one or two great efforts by a few people. We have only seen the beginnings of the possibilities in this movement. To appreciate the size of the undertaking, consider the number of subjects taught in the schools that lend themselves to curriculum development, considering for the purpose of discussion, all education, not just science education.

There are the academic or liberal arts subjects: mathematics and the physical sciences, including physics, biology,

chemistry; communications, including reading, writing, speaking, and listening; modern foreign languages; the social studies, including history, economics, psychology and, especially in the early grades, acquainting the student with the nature of the community and the world in which he lives; the humanities, which include music, art, and literature, and which are taught both from the point of view of appreciation and performance--playing a musical instrument or writing a musical composition. There are the occupations, the vocations, the technologies, and the professions, including teaching. In many subplots of the fields that make up these categories, the number of students may be sufficiently large and certain elements in the field may be sufficiently pervasive to warrant programs of curriculum development, remembering that curriculum materials include not only books, but also pieces of apparatus.

Simply indicating the range of subjects does not do full justice to the magnitude of the undertaking. Account must also be taken of various styles of learning, of kinds of minds. We know in an impressionistic way that some persons tend to think in concrete terms, others abstractly. We have experimental physicists and we also have theoretical physicists. Moreover, most of our educational thinking has been in terms of the middle class child. Without any implication that this means the production of watered down materials, a special approach, or several special approaches, may be necessary for children suffering the effects of deprivation or segregation. Some children are retarded, others are exceptionally able. All these considerations suggest that it will make sense to develop several sets of curriculum materials, even in the same subject.

Further, in considering the size of the task, consider the number of years of schooling that there are. The span covers kindergarten through the twelfth grade, to which should be added a year or two of preschool and four or five years after high school.

The fundamental unit of curriculum development, then, is a given subject for a given kind of student at a given age level, and the full extent of the undertaking is obtained by multiplying the number of subjects by the number of kinds of styles of learning by the number of school years. In one sense, the full enterprise is not quite this big. Obviously, not every subject taught in school has to be turned out in every style and not every subject is taught every single year. But in another sense the task is bigger. It is never ending because

successful work in one area will open up new possibilities for work in another area, and the task of education itself changes, demanding new materials, as society evolves.

3. Recommendations for New Projects

I. The time has come to involve undergraduates at teacher preparatory institutions in the business (art? science?) of curriculum development. Fundamentally, this means that prospective teachers must themselves get involved in preparing and trying out new materials: the materials to include apparatus, text, films--anything or something of everything. It also means conducting on a larger scale some programs already under way on a smaller scale: programs of practice teaching for prospective teachers based on selections from, or samples of, new curricular materials; involving working and prospective teachers in the testing of new curricular materials.

This recommendation follows from the approach to education mentioned earlier that stresses the method of involvement. If we believe that students should be taught by the method of involvement, then teachers must be taught by the same method--as distinct from conveying to them didactically the business of teaching, as if such knowledge could be poured from the head of the teacher of teachers to the head of the teacher. Teaching by the method of involvement is a pedagogical task and the way to teach that method is to involve teachers in that task. I believe that curriculum development can serve this end and, in this sense, it is both a subject and a vehicle, both an end and a means to other ends. In addition, through this kind of instruction, the teacher will become more experiment-minded in education and develop a fuller appreciation of the idea of constant evolution of the curriculum.

Getting prospective teachers involved in the business of curriculum development does not mean that the results automatically become part of country-wide courses. It also does not mean that we should press less hard at building up a certain number of curriculum development centers, in developing new materials at these centers, and in enlisting the talents of outstanding scientists and mathematicians in these efforts. Rather this approach is part of an effort to enable teachers to gain a better understanding of the new curricular materials and to help relate their own creative efforts to the work of others. A scientist does not personally have to rediscover all of science; he builds on the work of other investigators. This approach also

helps provide a new career line in education. At present, advancement generally lies in moving up the administrative ladder or in becoming a teacher of teachers, but there could also be a ladder in educational innovation. Curriculum development centers might play an important role here.

II. The time has also come to promote closer relationships between liberal arts colleges and institutions devoted primarily to the preparation of teachers. Curriculum development can play an important role here, too. Working on new materials, with appropriate persons from the schools and schools of education, is one way that scholars can make an effective contribution. Anyone familiar with work in curriculum development can quickly name the universities where there are university scientists and mathematicians already involved in curriculum development--Princeton, Berkeley, Illinois, Wisconsin, Harvard, M.I.T., and so on. These are the places to build new groups of professional scholars involved in curriculum development and to link them up with institutions that are primarily teacher training organizations. Other university scientists and mathematicians can then be drawn into these efforts.

The relations between the two kinds of institutions need not be highly formalized. They can involve the interchange of personnel and the institution of joint projects. In seeking closer relationships between liberal arts colleges and schools of education, work in the fields of science and mathematics has a special advantage: the schools of education are quicker to recognize their shortcomings in these fields than in other fields.

4. NSF's "Science Education Programs"

Let me turn from these general considerations to a consideration of the relevant sections of the NSF's plans for FY 1966. One comment first on such "general considerations" as found in the NSF document itself: what is lacking is any feeling of the scope and potential of the undertaking. I should think that some hint could be given without worrying everybody about Federal intervention in education. Of course, this should be done only in conjunction with an expanded program. Let me reproduce the relevant figures from the summary of obligations on page 182.

SCIENCE EDUCATION PROGRAMS

	Estimate FY 1966	Increment over FY 1965
Fellowships and Traineeships	$56,000,000	$15,800,000
Institutes	50,000,000	6,250,000
Research Participation and Scientific Activities for Teachers	6,300,000	2,400,000
Science Education for Undergraduate Students	8,500,000	2,500,000
Science Education for Secondary School Students	5,000,000	1,200,000
Specialized Advanced Science Education Projects	4,200,000	2,350,000
Course Content Improvement	16,000,000	2,000,000
Total	$146,000,000	$32,500,000

The bulk of the funds under the Science Education Programs are for Fellowships and Traineeships and for Institutes, a total of $106 million, with an increment of $22 million over FY 1965. This is compared to the amount of $16 million for Course Content Improvement, with an increment of $2 million over FY 1965. The remaining funds are distributed over various smaller programs.

If we distinguish between programs that are essentially operational and programs that are essentially research and development, then the Fellowships and Traineeships and Institutes constitute operational programs and Course Content Improvement constitutes research and development. And so we find ourselves spending proportionately less on educational research and development. This is too bad, because given the large operational expenditures for education by State and local governments, dollar for dollar, the most effective use of Federal funds is for research and development. For, as I understand it, the purpose of educational research and development is to multiply the effectiveness with which all operational funds are spent, to steer all expenditures to the support of better instruction.

And if we distinguish between longer-term educational needs (which can be met now but which reach down to elementary school) and shorter-term needs (the needs of students now in college or high school), then we find the longer-term needs neglected. Of course, this is no cause for concern unless you really believe that it is possible to learn something about science and mathematics in elementary school and that such learning can affect later learning in secondary school and college. Only the Course Content Improvement section really addresses itself to the earlier years. A few institutes are devoted to elementary school teachers, but essentially this program is not addressed to that level, and because of the vast numbers of such teachers cannot be addressed to that level.

5. Funds for Course Content Improvement in Sciences & Mathematics

PSAC and OST have made repeated statements supporting the vigorous improvement of curricula teaching techniques and teaching materials at primary, secondary, and college levels. This concern was reflected in expansion of the NSF Course Content Improvement program prior to FY 1963 and the more recent growth of a new OE program. But needs for curricula improvement are far in excess of available resources and, most important, funds for improvement of science and mathematics instruction have not

increased significantly since FY 1963. The table below describes the current situation.

	Obligations in $ x 10^6					
	1961	1962	1963	1964	1965	1966*
O.E. Curriculum Development	-	-	-	11.5	15.8	25.0
O.E. Funds for Science and Mathematics Only	-	-	-	-	0.6	0.7
NSF Curriculum Development	6.4	9.0	12.6	14.0	14.0	16.0
Total Science and Mathematics C.D. Funds	6.4	9.0	12.6	14.0	14.6	16.7
Total Federal Funds for Basic Research	804	1085	1395	1615	1891	2009

* Requests submitted to BOB in advance of the FY 1966 Budget.

It is apparent from the above table that in FYs 1964 and 1965 curriculum development funding as a percentage of Federal research and development obligations is dropping markedly from FY 1963 levels and does not even maintain the FY 1961 position. The prospect for FY 1966 is even less attractive. In this context it is interesting to note that NSF curriculum development requests to the BOB for FY 1966 funds are much lower than similar requests submitted in FYs 1963, 1964, and 1965. Perhaps optimism lives only three years!

Universities do have an opportunity to make use of NSF base grants for curriculum development activities. Also it is possible to include curriculum development as a part of "science development" proposed under a new NSF program to build new centers of academic excellence. But because the program is focused at the graduate level, this possibility appears remote.

6. Recommendations for Changes in NSF Budget

I. The support of Course Content Improvement should be increased at the rate of 45 per cent a year for five years. This is my estimate of the rate at which good people could be recruited to this effort and good programs could be mounted. Because most projects are carried for a number of years, the present increase

of only $2 million (barely enough to meet increasing costs because people on the projects grow older and earn higher salaries) gives NSF very little opportunity to fund new projects. But I don't think these good, new people will recruit themselves, so that this recommendation contains the provision that NSF make an active effort to initiate projects, employing the necessary staff and using a portion of the additional funds for that purpose. Again, I think this can be done without raising the cry that the Federal Government is interfering in public education.

II. The Institute program should devote 10 to 20 percent of its resources to educational research and development. Such research is not limited to developing new materials; as we suggested earlier, it also deals with the manner in which teachers are themselves taught. (It deals with a lot of other matters, too--self-contained classroom versus nongraded structures, team teaching structures, and so on.) Consequently, instead of viewing the institutes essentially as an operational matter, they can also be viewed as an experimental program. The institutes can be run as laboratory schools exploring better ways to teach teachers. When a good program is developed, it can serve as a model for those of our preservice teacher preparatory institutions that are searching for improvement. Making a portion of the institute into experimental schools for teachers would require additional criteria in the granting of funds. It is one thing to manage a teacher training institute, another to create a new kind of institute.

III. The Fellowships and Traineeships program should also direct 10 to 20 per cent of its resources to educational research and development. The time has come to start preparing people specifically in this line as well as continuing to draw upon scientists and teachers. One difficulty is that such fellowships are to be for work toward a degree. As far as I know, no institution yet gives a degree in science or mathematics education. But the kind of work the recipients of such awards could do is clear enough. They could be attached to curriculum development centers, to specific projects in course content improvement; or to the new experimental or model institutes.

IV. It may be that the other budget lines under the Science Education Programs would also lend themselves to being turned, a certain percentage, in the direction of educational research and development activities. In fact, some of them already are.

V. In the NSF budget, the Science Education Programs discussed above are followed by the Institutional Science Programs,

which include institutional grants and science development programs and total $127 million. It may be that a portion of these funds could also be directed to the support of educational research and development, especially to the support of the kind of projects mentioned earlier promoting closer relationships between liberal arts colleges and institutions devoted primarily to the education of teachers.

VI. This new emphasis on teacher education in its relationship to curriculum improvement should be reflected in the categories, and the titles of the categories, under "Science Education Programs". But simply setting up a new category title "Teacher Education" may not be the answer, because the whole idea is to connect teacher education to course content improvement, to connect the style in which the teacher teaches to the style in which he is taught. A way to handle this would be to expand the kind of programs supported under Course Content Improvement and perhaps enlarge the title correspondingly.

Thank you for giving me an opportunity to discuss the goals and scope of educational research and development and to offer some specific suggestions for the NSF programs. I will be glad to discuss these matters further with you.

Sincerely yours,

Jerrold

Jerrold R. Zacharias

Dr. Leland J. Haworth, Director
National Science Foundation
Washington, D. C.

Copies to:

Harvey Brooks
Philip Handler
Henry W. Riecken
Joseph Turner

APPENDIX III

October 18, 1976

TO: Jerrold Zacharias

FROM: Mitchell Lazarus

Thank you for sharing with me your letter of November 10, 1964, to Dr. Haworth of the National Science Foundation. Particularly interesting is that many of its issues, then new and fresh, have by now found a foothold in the public consciousness. So the past thirteen years have shown some progress. For example...

-- The fact that tests control content is widely recognized, forming one component of the current objections to large scale standardized testing.

-- The need for federal involvement in educational reform nowadays goes without saying. Effective innovations require funding on a scale usually not available from other sources.

-- That students need a variety of learning styles has become widely accepted -- to the point of becoming a basic tenet of both the open-classroom and individualized-instruction movements.

-- Likewise, the need for intensive teacher training -- particularly with student materials -- also has become an established principle in educational reform.

-- Most people in the field, I think, now recognize and respect your distinction between projects which simply continue existing activities, and those which strike out in new directions. Indeed, current proposal guidelines from NSF,

NIE, USOE, and the foundations often make this distinction explicit.

-- The need for close cooperation among different kinds of organizations also has become common knowledge. EDC can take some pride in having pioneered some of these interactions.

-- Finally, I believe everybody recognizes the immense scale of the problem. Some quail at it, throwing up their hands in dismay; others buckle down to working on one piece at a time. But the years since 1964 have made it dramatically clear just how big the problem is -- and just how much time and money the solutions will take.

In many ways, public awareness of these issues is due in large part to your own work. You can take some personal pride in your 1964 letter being partly obsolete.

On the other hand, since then, several other issues have risen to the surface:

-- On the matter of scale, we now recognize that the problem is not only vast, but fluid. Society's needs change; our understanding of the educational process changes; and in many fields the content changes too. The task of educational reform will be with us as long as there is education. Thus the scale issues comprise not only dollars, academic subjects, learning styles, and ages -- but also time.

-- To quote Paul Brandwein, "We are about to realize that there is nothing so unequal as the equal treatment of

unequals..." Students from different backgrounds sometimes do best with different kinds of educational materials, and we must acknowledge, respect, and accommodate to the diversity of American cultures. This multiplies the scale issue again along yet another dimension.

-- For several years now, we have seen disputes among proponents of various classroom styles -- for example, structured vs. open classrooms. In 1964 you needed to promote that many styles are necessary. Now that position sounds out of date, but we argue instead -- and often pointlessly -- about which styles work the best.

-- We understand better than we used to that teachers, as well as students, need options and flexibility. The "individual instruction" movement is one reflection (in some applications, a perversion) of this understanding, but we still must provide teachers with the varied means to reflect their own and their students' styles.

-- The content of education is changing, both in elementary school and in high school. The "back-to-basics" movement reflects one kind of change, but there are others too, in almost every subject area. A generation ago there was little argument on what students should learn between Kindergarten and Grade 12, but since then, almost all the long-held assumptions have come into question -- for example, the teaching of arithmetic, standard English, and Judeo-Christian values.

-- Finally, and most sensitive of all, we now discuss who should control education. At one time everyone agreed that school boards and educators should, but now we see increasing demands for participation by parents and the rest of the community. The potentially positive outcomes include a better integration of the schools with the community as a whole, and greater community involvement in the schools. But there is also some risk of short-term decisions that threaten the broader goals of education, and of actions that fail to recognize the subtleties and complexities of the subject matter.

Educational television too has become prominent and important since 1964. In its early days, classroom television was little more than a moving textbook. "Sesame Street" changed that, by showing that television could be both educational and still appealing enough to win viewers on its own merits.

Television now can play two main roles in education. First, it can sell educational content as it sells deoderant. My daughter at age two, having decided from watching "Sesame Street" that reciting the alphabet and the numbers would be fun, asked her mother and me for instruction. Second, television can deliver into the classroom a variety of experiences unavailable otherwise. An "Infinity Factory" segment, for example, shows a group of children painting

a wall mural, first solving the problem of enlarging a sketch without distorting its proportions. To be most appealing, the problem needs more scope and scale than a classroom can provide.

But we still have not made television that can teach anything but small, simple, discrete objectives. This is enough for some areas, such as the alphabet and some parts of elementary mathematics. It breaks down, however, in subjects that resist orderly analysis into small parts, such as history, literature, and the social sciences. "Electric Company" provides an interesting case study: It fails precisely because it treats a complex, interwoven subject -- reading -- as the sum of simple objectives.

Making good educational television about history, say, may demand a new and different understanding of what we want to teach under that name. Television will do poorly with causes and effects of wars, successions of presidents, and the roots of one doctrine or another. But we could use television to convey a strong sense of what it must have been like to grow up during the Revolution, listening to talk of war in the inns, brushing past British soldiers in the street, and trying to decide for oneself whether the issues and emotions warrant fighting, and perhaps dying, for the sake of separation from England.

The classroom is a sterile place, compared to the rest of the child's world. Educators now are seeking ways to break

out of the classroom, to put down pedagogic roots in the community as a whole. Television can be a great help, if we learn to use it properly, and if we can let go of some centuries-old ideas -- not just about content, but about style too.

* * * * *

I hope this is helpful. If you ever find the time to write it, a letter analagous to the 1964 piece, but reflecting the needs and concerns of 1977, would make fascinating reading.